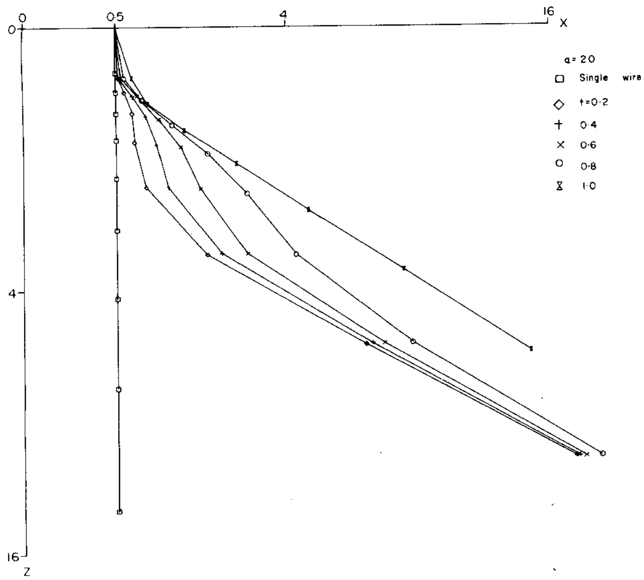

FIGURE 2

Loci of maximum emf produced by the circuit in Figure 1. As *a* increases, the possible deviation also increases.

THE TRANSIENT EM TECHNIQUE – NEWMONT'S SYSTEM IN AUSTRALIA

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The Newmont Electromagnetic Pulse (EMP)

Newmont Proprietary Ltd. has been operating a transient EM system in Australia since August 1976, and has surveyed more than 100 line km, in that time. In Australia the system has successfully located massive sulphides at depths in excess of 120 m, and in Canada orientation surveys indicate that mine size targets can be detected at depths approaching 300 m. The experience gathered to date strongly suggests that detection of mine size targets at depths in excess of 200 m, is possible even in areas of conductive overburden.

For the summary which follows some understanding of the normal operating mode of the equipment is required. Briefly a rectangular loop of uninsulated aluminium cable, 800 m by 400 m is laid out on the ground, with the long side parallel with the regional strike. The exact location of the loop depends on the attitude of the targets to be illuminated. A transmitter drives a current into the loop and abruptly breaks that current every 750 msecs. The loop current may be varied between 20 and 100 A. Typically 80 A are used when about 13 KVA are dissipated in the loop, and the current required about 1 msec to fall to zero. A switch allows the pulse width to be set at 20, 40 or 80 msec. The 750 msecs cycle is a compromise between operational speed and reasonable transmitter battery life.

The secondary magnetic field is detected by a 5 feet by 3 feet air cored coil connected to a receiver by a 10 m cable. The coil is sensitive and yet practical for one man to carry the coil has legs, spirit levels and a compass, and may be oriented in any one of 3 mutually perpendicular directions. The directions are related to the grid with Z recorded as positive down. The receiver amplifies and samples the decaying voltage in the coil at 16 discrete points in time, after the transmitter pulse cut-off. Four overlapping windows allow the voltage to be sampled between 0.6 and 70 msecs; two windows cover the range with four common samples. The signal is stacked 14 times and then recoreded on tape for later processing by computer, and on paper tape for field scrutiny. A minimum of two readings is required, but as many readings as desirable may be taken. These data are then stacked, in a more intelligent way by computer during data processing.

The Half Space Response

The interpretation of transient EM, where the receiving coil is not coincident with the transmitting loop, required an understanding of the current distribution in the ground and its variation with time after current turn off.

Both Nabighian (1978) and Lewis and Lee (1978) have computed the electric field within the earth resulting from a current step in the transmitter loop. Briefly the resulting electric field can be compared to a "smoke ring" which moves downwards and outwards from the loop centre at an angle of 30° at late times. Also at late time the response of the vertical and horizontal fields created by the current flow vary as $\tau^{-2.5}$ and $\tau^{-3.0}$ respectively. Lee (1978) also des-described an equivalent "current axis" propagating in the half space where is radius varies as $\sqrt{\tau/\sigma}$

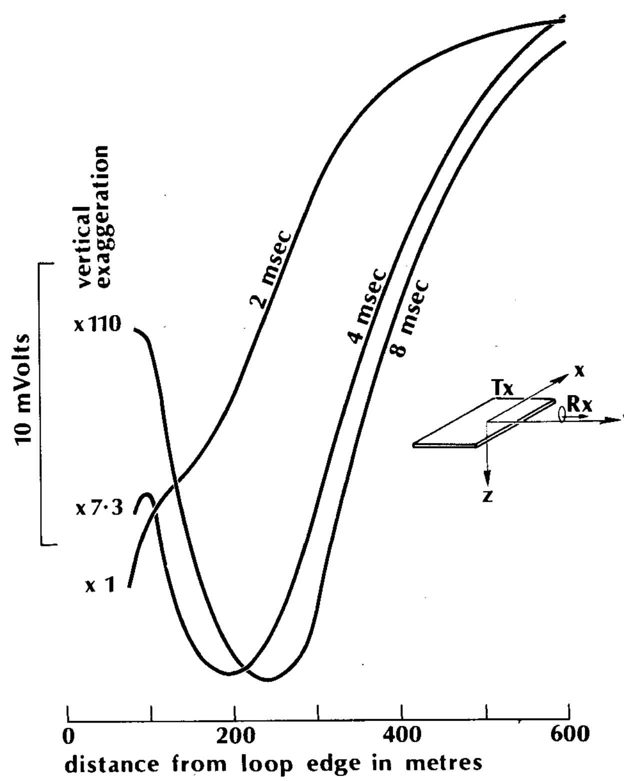

FIGURE 1

Half Space Response For Horizontal Component.

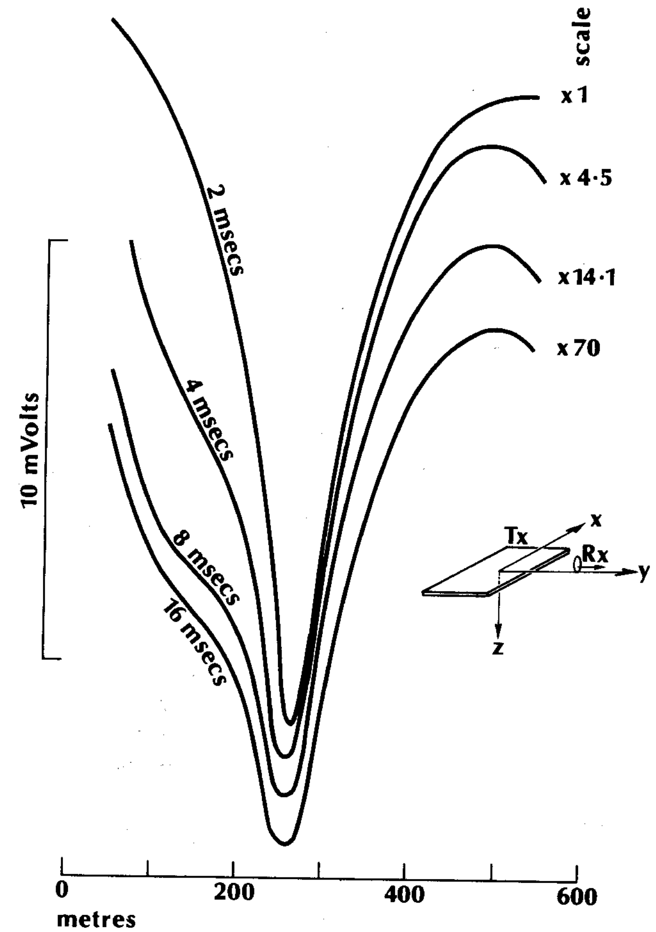

Figure 2. Horizontal Component - Strong Conductor

FIGURE 2

Vertical Response To A Tabular Sub-Vertical Conductor, Horizontal Component.

It becomes clear from this that all the essential features of the half space response can be explained by imagining a current filament moving away from the loop at a constant angle where the area enclosed by the filament is increasing as t and its amplitude is decreasing at the same rate, and its velocity is dependent on the conductivity of the half space.

Figure 1 shows a response over a half-space and it is easy to imagine that a moving current filament could produce such a response. The response of course is dBy/dt and not By, and the vertical scale exaggeration is required to compensate for the $\tau^{-3 \cdot 0}$ amplitude fall off. Being the voltage and not the field, the response in time shifted, and the filament has already passed through the minimum; it is however important to note the shift of the minimum with time. The movement of the minimum or maximum is a requirement of the half space, and this clearly distinquishes it from the response from a vertical tabular body.

The Vertical Tabular Body Response

An eddy current will be induced in a vertical tabular body of higher conductivity than the host medium, following the cut-off of the primary field while ever the body is linked by the primary flux. Kaufman (1978) has described the behaviour of bodies of various geometry and in particular the response of a finite body as:—

$$E\ (t) = \sum_{n=1}^{\infty} a_n\ ^{-q_n \alpha t}$$

the sum of exponentials. At late time a single exponential will dominate, with the rate of decay being longer for conductors of better quality, although the amplitude may be smaller, as a_n in proportion to $1/\sigma$. Systems with large transmitters will tend to excite lower order dipoles in the target body, and for large targets the size of the eddy will be limited only by the dimensions of the transmitter itself. Necessarily these eddy currents will take longer to decay, and will yield a decay constant which reflects the size of the target.

The other important consideration of course is the fact that this induced eddy current must dissipate as heat within the conductor and therefore, except for contraction with time, is stationary.

Figure 2 shows the horizontal field response observed over a conductive target of limited strike length buried to a depth of about 120 m. Importantly the peak response has not significantly shifted from 2—16 msecs. The signal is purely exponential at late time with a time constant of 40 msecs, and is much slower than the space response shown in figure 1.

A large, fixed transmitter loop system of high power, with vector field measurement, can be used to great advantage in the search for massive sulphides, so long as the interpreter has a good understanding of the nature of the response to be expected.

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JOINT MAGNETOTELLURIC – DC RESISTIVIY SURVEY EASTERN OFFICER BASIN *

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The Eastern Officer Basin is one of a number of poorly known onshore sedimentary basins (Figure 1). Although there are scattered exposures of Paleozioc sediments, the surface is largely covered by sand hills of the Great Victoria Desert. On the north it is bounded by the Everard Ranges of

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